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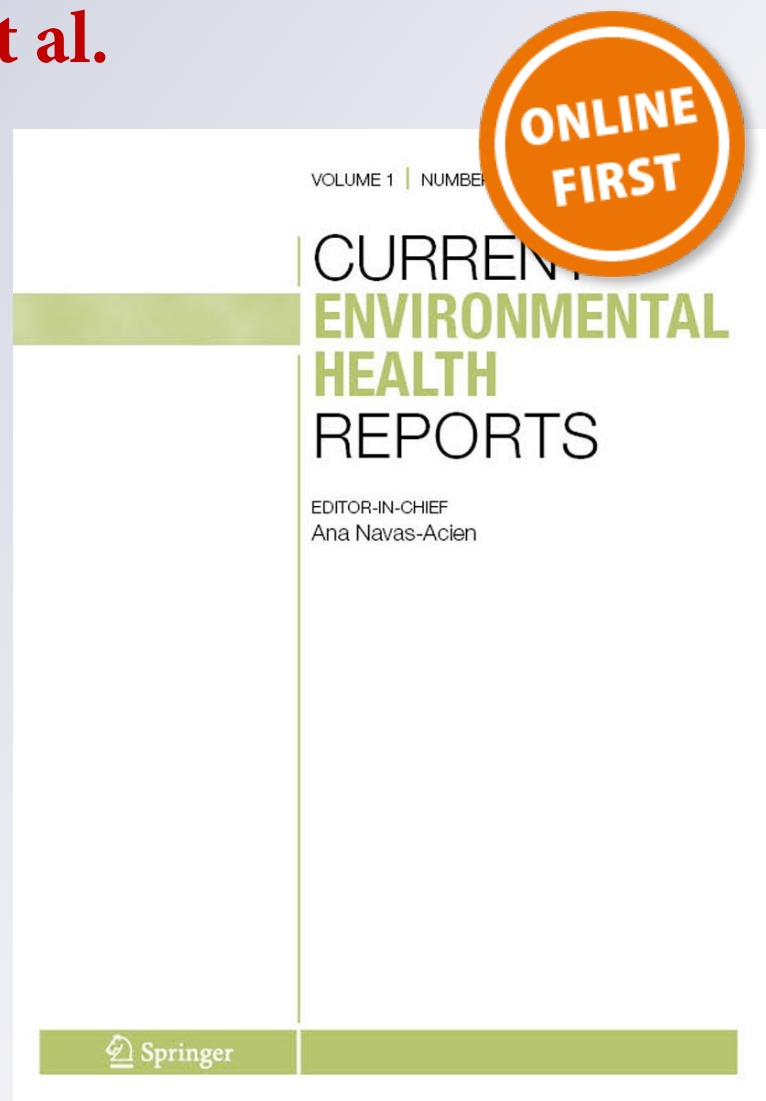
Agroecology and Health: Lessons from Indigenous Populations

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Agroecology and Health: Lessons from Indigenous Populations

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Abstract

Purpose of Review The article aims to systematize and disseminate the main contributions of indigenous ancestral wisdom in the agroecological production of food, especially in Latin America. For this purpose, it is necessary to ask whether such knowledge can be accepted by academia research groups and international forums as a valid alternative that could contribute to overcome the world's nutritional problems.

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Recent Findings Although no new findings are being made, the validity of ancestral knowledge and agroecology is recognized by scientific research, and by international forums organized by agencies of the United Nations. These recommend that governments should implement them in their policies of development, and in the allocation of funds to support these initiatives.

Summary Agroecology and ancestral knowledge are being adopted by a growing number of organizations, indigenous peoples and social groups in various parts of the world, as development alternatives that respond to local needs and worldviews. Its productive potential is progressively being recognized at an international level as a model that contributes to improve the condition of people regarding nutritional food.

Keywords Agriculture · Ancestral knowledge · Alternatives · Coloniality

Introduction

In the report of 2015 titled "The State of Food Insecurity in the World", the United Nations Food and Agriculture Organization FAO stated that, "About 795 million people worldwide do not have enough food to live a healthy and active life. That is almost one out of nine people on earth" and "Poor nutrition is the cause of almost half (45%) of deaths in children under five—3.1 million children each year," especially in developing countries [1]. This information reflects one of the major criticisms of modernity, that despite its technological development it is far from overcoming the main problems that humanity faces nowadays.

During the 1970s a group of scientists around the world, supported by The Club of Rome and The Massachusetts Institute of Technology, developed a

mathematical model of the major trends of global concern: accelerating industrialization, rapid population growth, widespread malnutrition, depletion of nonrenewable resources, and a deteriorated environment, from a space-time perspective. In Club of Rome's report "Limits to Growth", the main conclusion was that "If the present growth trends in world population, industrialization, pollution, food production, and resource depletion remains unchanged, the limits of growth on this planet will be reached sometime within the next one hundred years... It is possible to alter these growth trends and to establish a condition of ecological and economic stability that is sustainable far into the future" [2]. They urgently called for immediate action to overcome the critical problems associated with global, social, economic and environmental trends.

Ancestral indigenous knowledge and agroecological practices, which this paper addresses, constitute an important intervention strategy that could help deal with some of the persistent problems previously outlined.

Hegemonic Agricultural Modernization

In the early 1960s, several authors began to criticize the notion of modernity, both from the perspective of the Critical Theory [3] and the Colonial School [4, 5], considering that it determined the current multidimensional crisis, which involves: economic, political, social, cultural and environmental factors. These factors are also part of the growing poverty in the world, food and energy crisis, increasing social conflicts, repression, violation of human rights, militarization and war, and an environmental crisis that threatens the existence of the world and humanity itself [6, 7].

Industrial modernization changed the forms of exploitation of agricultural systems that became hegemonic after World War II [8]. This includes the implementation of the "green revolution", a new technological package that introduced agro chemical inputs, genetic modification of plants and animals, and agricultural machinery and equipment as a strategy to fight hunger and to increase the performance and the profitability of agriculture [9]. Even though this approach increased the yield production, it resulted in a multitude of negative effects: the loss of biodiversity, land degradation, environmental pollution, contamination of aquifers and food resources, destruction of natural ecosystems, and serious impacts on human health [10], along with the loss of traditional practices carried out by many communities around the world.

According to Petersen, the modernization of agriculture has modified the cultural basis of agriculture, transitioning to agro-industrial processes [11], which changes the dynamics of agriculture at the international, regional and

local contexts, ignoring the uniqueness of ecosystems and local cultures [12, 13].

Environmental Impacts

Agricultural modernization has also led to severe environmental impacts, due to indiscriminate use of chemicals that have contaminated groundwater or surface water, the excessive use of nutrients that led to eutrophication processes, and the loss of organic material and soil micro biota that reduced soil fertility. Other repercussions include high rates of fuel and water consumption, nutrient leaching, deforestation due to the expansion of agricultural and livestock frontiers, and the loss of biodiversity in natural ecosystems [14]. It has affected the sustainability of agricultural production in many parts of the world, especially in developing countries.

Health Impacts

Since their introduction after World War II, pesticides have generated important agricultural benefits. Unfortunately, they have shown to be toxic to different species, and have generated public health problems mainly in developing countries [15]. The World Health Organization estimates between 500,000 and 1,500,000 acute poisonings, of which between 3000 and 28,000 deaths occur per year [16]. The International Labour Organization recognizes that 2% of agricultural workers in developing countries suffer from some type of poisoning, from which approximately 10% are fatal [17]. Additionally, the auto-ingestion of pesticides has become one of the main methods of suicide worldwide, estimated in 250,000 suicides by pesticides, a third of all suicides that occur in the world [18].

Other adverse effects of pesticides on human health are damages to the nervous system (e.g., Parkinson's disease), as well as pulmonary, reproductive, endocrine and immune system damage. Chronic toxicity results from the cumulative effects associated with the development of chronic diseases such as: leukemia, lymphomas, sarcomas, and other cancers [19], diabetes, neurodegenerative disorders, Parkinson's disease, Alzheimer's disease, amyotrophic lateral sclerosis, congenital malformations, renal disease, and autoimmune diseases such as lupus erythematosus, rheumatoid arthritis, and chronic fatigue syndrome [20–22]. Based on their processes of active cell division, embryos, fetuses, newborns, and children are the most sensitive to toxic chemicals [23]. The addition of genetically modified organisms resulted in genotoxicity defects, teratogenicity, and cell damage [24].

There are reasons for concern regarding neurobehavioral and endocrine disorders, such as thyroid, ovarian, prostate

and testicular dysfunctions, obesity, type 2 diabetes, cognitive deficits, changes in human behaviors, with irreversible damages that are not evident until much later in life [25–29]. There is abundant information about the potential harmful effects of various types of pesticides, from those that inhibit cholinesterase and induce acute nephrotoxicity [30] to those that affect memory, recognition, behavior, and motor coordination [31].

Social Impacts

Agricultural modernization has followed the strategies of macro industrial companies that seek hegemonic domination [32, 33]. It has transformed the socio-cultural patterns of living and the organization of labor in the countryside [34]. Food began to be seen as a commodity that results in economic profits rather than a means to provide a person's nutritional requirements [35]. This has affected food provisions and food security in different countries in Latin America [36].

Agricultural modernization has tended to concentrate on land ownership structure [37], favoring business development with negative impacts on marginalized communities, leading to their impoverishment, and the expulsion of families from the farmland [12]. These structural problems are evident in many ways, from the concentration of land and future markets to monetary tightening policies, deregulation of trade laws, privatization, and free trade [38], which aggravated overexploitation and pollution of natural resources, conflicts, violence and death in the field. In the face of these challenges, many indigenous and social groups have proposed alternatives for this type of agricultural development.

The Construction of Alternatives

There has been a growing concern from indigenous groups, social organizations, and academia around the world about the social, health, and environmental impacts of the industrialized agriculture, and the need to create alternative solutions.

Indigenous Proposals

The indigenous movements of the last three decades wish to recover their cultures, wisdoms, and practices. Their starting point is the need to strengthen paradigms based on community principles (reciprocity and relationality) [39, 40] in the construction of social relations as well as in the relationship with nature [41]. This is exemplified in the agricultural production in various ecological zones, which has allowed the communities to have access to a variety of food products [39].

One of the most important elements that indigenous movements have highlighted is the need to incorporate the concept

of INTERCULTURALITY as a political, ethical, and epistemic process. This is in response to the hegemonic geopolitical monoculture, so as to incorporate values, principles, knowledge, and wisdom of the indigenous people, to build a unique setting, and to represent an effort to achieve a cultural self-identification [42].

Ancestral knowledge of agricultural production can be found in the daily practices of the elderly peasants in the Andean region. It is mostly transmitted from generation to generation, and it is organized in small scale local agricultural production. However, there are multiple published compilations which refer to such practices in various regions of Latin America [43–45].

In North America, similar discussions have taken place around the concepts of traditional ecological knowledge, tribal ecological knowledge, indigenous knowledge or even Native science, understood as the knowledge or wisdom acquired by indigenous and local people over centuries. These practices and beliefs passed from generation to generation by cultural transmission constitute the bases for natural resource management, as a way to reestablish more intimate relations with the natural world, that has been lost by modern society [46, 47].

Regaining the Indigenous Wisdom and Worldview

Enrique Cachiguango (one of the indigenous intellectuals in Ecuador) refers to important concepts regarding the indigenous way of thinking [44]. In a personal talk, Cachiguango states that “One of the most important philosophical principles is that the world is a living thinking being (self-conscious), with feelings and knowledge. The atom of matter, the water molecule, animal and plant cells are all alive and intelligent. That is why in the vocabulary of indigenous languages everything is considered a living being” [48••].

Cachiguango talks about examples of the core ideas. For instance, “the concept of Pachamama (Mother Earth) given to nature by the Kichwa people reflects the importance they give to the Earth and the environment. It was conceived as a large cosmic female body (breast) where clusters, galaxies, systems, stars, planets, mountains, wind (air), fire, earth, water, minerals, plants, animals, and humans are part of the same cosmic body, therefore, these beings are interdependent and interrelated. This explains the deep respect, love, and care for nature of the indigenous communities, as well as the interconnectedness of humans to nature, to the gods and to their ancestors” [48••].

The indigenous point of view rescues the notions of balance, harmony and plenitude, diversity of people (indigenous, peasants, and rural women), cultures, environments, and livelihoods [49]. In Latin America, the practical foundation of an ecologically based agriculture has its origin in the 1970s, emerging as a counter-movement, as an alternative way to contrast the policies of agricultural modernization [50]. It

combines popular knowledge with various scientific disciplines [51, 52] through participatory research, with a multidimensional perspective—economic, social, environmental, cultural, political, and ethical [53]. Agroecology seeks to produce in the most organic way possible by adding bio fertilizers, crop rotation, multiple crops, permaculture, drip irrigation, and biological pest control [54]. They recognize ecological principles within the design and management of sustainable [55], socioeconomic, and cultural agroecosystems [56]. Their goal is to recover the people's knowledge [57] in order to improve the living conditions of the poorest people [58]. Agroecological production could be developed approximately in a year, especially in those tropical region countries, which are not affected by climatic seasons, providing diversity of food at all times.

Most of the indigenous ancestral knowledge has been transmitted from generation to generation, and quite often it is not possible to identify written materials in this regard. Two of the indigenous authors of this article have been able to provide additional insights about this matter. As Cachiguango explains “From the indigenous perspective, the agricultural cycle requires knowledge of astronomy (movements of the sun, moon, and stars), as well as the wisdom of “reading” nature (i.e., behaviors of the surrounding natural beings, known as natural meteorology, which is the basis of Indian spirituality)”. Cachiguango also states that “beings from the largest (macro) to the smallest (micro) are part of the same organism, of all bodily and spiritual beings. This resulted not only in a vision of the cosmos but also a cosmic experience (living according to the rhythms of the cosmic heartbeat), living and celebrating the life of the world and venerating death as a change in the state of life. Indian rituals are the mechanisms to create dialogue with various cosmic beings who have the ability to unbalance (sicken) and rebalance (heal) life on Mother Earth”.

“The agro-astronomical cycle reflects the indigenous understanding of the universe, which defines the four stages of the organization of the Andean agricultural production, which is also associated with the indigenous celebrations of solstices and equinoxes (Fig. 1). “

Indigenous Contributions

According to Hilario Morocho (the indigenous leader from La Esperanza, Pichincha, Ecuador), “The majority of indigenous communities on our planet have mainly subsisted on agriculture in a natural way. Thanks to them we can now enjoy a great diversity of food.” In Latin America there has been a wide development in the recovery of ancestral agricultural practices among the indigenous peoples in the area of Chiapas, Mexico; COINDI organization in Guatemala, COMSA group in Honduras, Landless Workers movement in Brazil and several

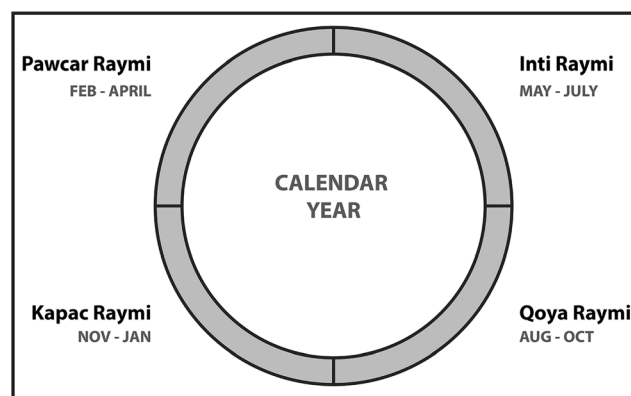


Fig. 1 “The agro-astronomical cycle reflects the indigenous understanding of the universe, which defines the four stages of the organization of the Andean agricultural production, which is also associated with the indigenous celebrations of solstices and equinoxes: **Qoya Raymi** (August-October) is a period of intimate connection with the land, as a dialogue and a prayer; **Kapaq Raymi** (November-January) is a gestation period of Mother Earth, when female forces of nature are at their peak; **Pawkar Raymi** (February-April), is a period of mutual nurturing of life: “nurture life and be nurtured by life, when Father sun has “returned” from the South to help us ripen the fruits of the chakra. It corresponds to the male equinox on March 21 (known in Kichwa as Hari Kuri Ñan); **Hatun Puncha / Inti Raymi** (May-July) is harvest time, that awakens the feeling of connection with nature” [44]. “In this cycle Kawsayta Wiñachina or “nurturing life” takes place, which collects and interprets the essence of the knowledge felt and known by indigenous peoples of the Andes. It is a concept that local world views, spiritualities, practices, and knowledge originate”

Andean indigenous peoples of Peru, Bolivia, and Ecuador [59]. The agroecological production of these groups provides food for up to 60% of the people in large cities. From all of these experiences, the organic producers of ASOPODAR in Costa Rica constitute a model experience, to be studied and replicated by other peasant communities”.

Many of these experiences were documented at the 49th International Congress of Americanists, held in Quito-Ecuador in 1997, which included a seminar on Andean Cultures and Technologies, organized by the Institute for the Study of Andean Culture and Technology (IECTA) [60].

Social Movements Proposals

The indigenous and agroecological thinking developed as part of people's struggles for identity, political recognition, land, and natural resources. The agroecological movement has continued to develop since the 1960s in order to overcome many of the problems generated by industrialized agriculture [61]. Several social groups have proposed a new method of the development model called the Via Campesina, which includes demands for land reform, changes in marketing policies, access to credit, rural education, democratic access to water and seeds, contextualized technical support, and increased political participation of indigenous peoples, peasants, women, and

rural youth, in order to attain food security and food sovereignty [62].

There has been a resurgence of a network of peasant organizations that are struggling to maintain their traditions and community life surrounding smaller plots, including the recovery of native food seeds, medicinal plants, native plants, and animal breeding, to enhance communities' and families' diet.

These networks of peasant organizations propose the development of an agro-ecological production where ancestral knowledge is combined with modern technologies to restore soil fertility (microbial life), a rational use of water, agroforestry, soil protection against erosion and desertification, and the recovery of productive diversity [63]. Within a broader social movement in the world, the concept of agroecology developed as a strategy to achieve food sovereignty and to defend their life and culture [64].

Agroecology in Latin America has always been linked to agrarian movements and peasant social struggles [65, 66]. These movements have increasingly consolidated larger groups, such as the Agroecological Movement of Latin America and the Caribbean (MAELA), the Latin American Scientific Association of Agroecology (SOCLA), the Brazilian Agroecology Association (ABA), Via Campesina as an International Peasant Movement, the Latin American Coordinator of Field Organizations (CLOC) [67–71], and the International Foundation for Organic Agriculture-IFOAM, with subsidiaries in more than 100 countries [72].

Agroecology has significantly developed in Cuba, after the fall of the Soviet Union, with the Peasant-to-Peasant process (CAC) promoted by the National Association of Small Producers (ANAP). This allowed local farmers to increase the resilience of agroecological production systems against hurricanes, droughts, floods, the recovery of previously degraded soils, and the production of healthy food for the sovereignty and food security of the country [73]. In Africa, there are also some important experiences in the development of agroecology, which have contributed to reduce human diseases, such as anemias [74], malaria [75], and HIV [76].

Within several developed countries, the articulated development of agroecology concepts, which integrates traditional knowledge such as experiences and practices, developed in rural communities over centuries. This has led Veterinarians without Borders [77••] to raise the concept of health, as a new vision of public health that incorporates ecological principles in the relations between human beings and the biological world, oriented to change the conditions that allow good health, from: a) the material conditions of existence (water energy matter), b) biological dimensions (Biophysiological processes that affect animals, plants, microorganisms, and the human species), c) cultural dimensions that signal how people think, and build interpersonal, family, and

community relationships, and d) social dimensions, which are expressed in terms of laws, social agreements, conventions, and the organization of life that occurs outside individual control [78••, 79–81].

International Recognition

The progress of these alternative proposals toward simultaneous improvement of agricultural production, environmental health, and human health [82] has reached international forums such as the symposium organized by United Nations Food and Agricultural organization on Agroecology for Food Security and Nutrition [82].

At the international level there have been important agreements regarding the concepts of food security, defined as the physical and economic access of all people to sufficient, safe, and nutritious food to meet their dietary needs and food preferences in order to achieve a healthy and active life. However, this concept has been expanded into the one defined as food sovereignty. It focuses mainly on the people's need for food, supporting sustainable livelihoods, reducing the distance between suppliers and consumers, placing control in the hands of local food suppliers, the need to inhabit and share territories, rejecting the privatization of natural resources. Among other example, we can include the construction of traditional knowledge, using research to support and pass on this knowledge to future generations, rejecting technologies that undermine local food systems, and maximizing the contributions of ecosystems, improving resilience, and rejecting energy intensive, monocultural, industrialized, and destructive production methods. This concept adds importance to cultural practices which focused on small-scale agriculture, preferably organic, mainly using the concepts of agro-ecology, permaculture, and agroforestry [83].

At the level of the United Nations system, the need to redefine agricultural and food policies in the world, to expand social protection systems in all countries, and to create a social global protection fund at the international level has been acknowledged [84].

The recognition of the role of indigenous peoples as protectors of natural resources, their ancestral knowledge, management of the natural environment, and the contribution of these peoples to sustainable development, as well as to economic, social, cultural, and physical well-being has been recognized by international norms, such as Convention 169 of the International Labor Organization (ILO) [85, 86].

Conclusions and Recomendations

Indigenous groups in Latin America have raised, as one of their claims, the need to develop a new social organization

that comes from the people, in order to react to their culture, wisdom, and worldview in defense of the Pachamama, as one of the solutions for the current world food crisis. They seek to restore harmonious relations between human beings and nature, for instance, people living together peacefully, integrated into a pleasant arrangement [87], under the principles of solidarity, based on meeting the interests, objectives, standards, and sympathies, that bind people together as one [88], and complementarity when creating alternative agriculture, and building dynamic and sustainable rural communities [89]. They are building an innovative and critical epistemology, which comprehends the creation, structure, limits, justification, and spreading of knowledge [90]. All this from historical perspectives raised by and from the subaltern subjects, by their current demands, as well as their expectations of the future, in opposition to the dominant neoliberal paradigms [91].

Even though the potential of agroecology is important, the access to natural resources, like soil and water, is highly relevant, and closely associated with the political support in each of the countries. It is important to generate a change in the development paradigm, which should incorporate a stronger goal to benefit the people in a sustainable ecological way. Considering the situation of the current multidimensional crisis in the world, the whole human society should learn from the indigenous perspective which involves establishing a harmonious relationship, based on solidarity and reciprocity, among human beings, as well as with nature. The majority of the current social, economic, and environmental problems could be solved if the world followed those paradigms.

It is important to emphasize a statement in the recommendation of the UN Special Rapporteur on the Right to Food, Olivier De Schutter 2014: the eradication of hunger, malnutrition, and the reduction of poverty are objectives to be achieved by strengthening agroecology and small farmers, this increases the resilience and sustainability of food systems in the face of climate change. This has been recognized by the scientific community in the International Assessment of Agricultural Knowledge, Science and Technology for Development, which recommended in 2014 that countries should create state policies to support the adoption and strengthening of agroecological practices [92••].

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Compliance with Ethical Standards

Conflict of Interest José Suárez-Torres, José Ricardo Suárez-López, Dolores López-Paredes, Hilario Morocho, Luis Enrique Cachiguango-Cachiguango, and William Dellai declare that they have no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies performed by any of the authors on human or animal subjects.

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